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Height-Growth Comparisons of Some Quaking Aspen Clones in Arizona

John R. Jones and David P. Trujillo[1]

Height-over-age curves of dominant trees were compared for five pairs of adjacent clones in 70-yr-old aspen stands. Sample trees of a pair occupied a common site. Apparent uniformity or non-uniformity of height was not a criterion in selecting pairs. In the three pairs with significantly different heights, the differences developed in early life. In one pair the difference was large, suggesting possibilities of selecting clonal material for planting. At age 30, all 10 clones would have seriously overestimated aspen site index (base age 80). By age 50, site index estimates would have been reasonably accurate.

Keywords: Clonal differences, height growth, site index, *Populus tremuloides*.

Different bigtooth aspen (*Populus grandidentata* Michx.) clones growing side by side on the same site may differ substantially in height growth (Zahner and Crawford 1965). Presumably such height growth differences result from genetic differences. This explanation seems much more likely than the alternative—that clonal boundaries commonly coincide with large and abrupt but invisible changes in site or history.

Zahner and Crawford did not include quaking aspen (*P. tremuloides* Michx.) in their study. They suggested, however, that genotypic differences in the height growth of quaking aspen clones may be less than between bigtooth aspen clones. In support of that opinion they cited personal communication with J. H. Stoeckeler and R. O. Strothmann, research foresters with extensive experience in the Lake States.

Graham et al. (1963) believed that substantial genotypic differences in the growth of aspen clones in Michigan afford a major opportunity to improve timber yields. Their statement did not differentiate between bigtooth and quaking aspen, nor did they provide support for their experienced judgment.

In the western United States, Cottam (1954) and Egeberg (1963) studied genotypic differences in quaking aspen phenology in Utah and Colorado, respectively. Each paper included a photo showing a clone in leaf standing beside a clone whose buds had not opened. In each case, though the authors did not comment on it, the heights of the adjacent clones were very different.

This Note compares the height growth of some pairs of quaking aspen clones growing side by side in Arizona.

[1]*Principal Plant Ecologist and Forest Research Technician, respectively, located at Station's Research Work Unit at Flagstaff, in cooperation with Northern Arizona University; Station's central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.*

The Study Area

The study area was chosen for accessibility, the abundance of aspen on favorable sites, and because decay was virtually absent from most stands. It is at 8,800 to 9,000 ft (2,680 to 2,740 m) elevation along a 2-mi (3-km) stretch of Forest Road 154, on the Black River District, Apache National Forest, in east-central Arizona (fig. 1).

Figure 1.—Healthy 70-yr-old aspen on the study area.

In 1903 or early 1904, fire burned through the mixed conifer forest of the area. Where the fire was severe enough to kill the conifers, aspen suckers took over, and the present forest is a mosaic of mixed conifer stands and small stands of mature aspen.

The area is on the southern rim of the White Mountains, where they drop rather abruptly southward toward the Basin and Range Province. It is therefore exceptionally moist, receiving approximately 33 inches (850 mm) average annual precipitation, about 45 percent falling as snow from November through March and about 30 percent as July and August rains.[2] This abundant precipitation, in conjunction with silty clay loam and silty loam soils, provides conditions favorable to good aspen growth.

[2]*Based on precipitation records from similar elevations 5 mi (8 km) northeast and 25 mi (40 km) northwest.*

Methods

Study clones were located by driving slowly along the road in late September. The foliage in some clones had turned yellow and in others was still green, making differentiation between clones easier than usual. Other clonal boundaries were first recognized by bark differences or by differences in the tone of green foliage. Each distinguishable clonal boundary along the road was examined. No clonal pair was accepted for sampling unless standing trees were readily assignable to one clone or the other, and unless the site appeared entirely uniform over an area large enough for a full sample. Irregular terrain ruled out a number of pairs. The first five suitable pairs were used. They were taken as they came; apparent contrast or uniformity in height were not criteria.

Within each clone, five dominant trees made up the sample. These were trees at least as tall as any adjacent tree, and taller than most. In an effort to distribute any unseen site dissimilarities as uniformly as possible between the two clonal samples, all sample trees were selected close to the clonal boundary. No tree was chosen, however, which competed directly with the crown of a tree in the other clone. Some of the sample trees in each clone were nearer to sample trees of the other clone than to some in their own.

Sample trees were felled and their heights measured. Cross sections were cut at stump height and at measured intervals up the bole, for ring counts. The cross sections were dried and rings counted in the laboratory

The number of rings for each cross section in a tree was graphed against section height. Section height was the independent (fixed) variable and ring count the dependent variable. If there were 65 rings at 8 ft (2.44 m) above the ground in a 69-yr-old tree, the tree must have passed 8 ft in height sometime during the fifth growing season and was, of necessity, taller than 8 ft, perhaps 9 ft (2.74 m), by the end of the year. To assume that the section height marked the end of a year's height growth would introduce a small but consistent error. Therefore it was assumed that the height-growth rate had been linear between two cross sections, and that each cross section was the midway point in a year's growth. This reduced the error and largely freed it from bias.

With these assumptions, estimated height for 1906, 1910, and each subsequent fifth year was graphed, with calendar year treated as the independent variable and height as the dependent variable.

All the stands were the same age. The oldest sample trees in each clone had 70 rings at stump height; almost all the rest had 69 or 68. This age pattern fits the course of aspen stand establishment which sometimes follows fire in mixed conifer forests in the southwest: suckers originating the first summer following fire do not totally occupy the site, and numbers may increase for a few years[3] (Patton and Avant 1970).

The average height of each clone in 1973 was compared statistically with its partner, and their height-over-age curves were compared graphically.

Results

The average heights of clones in 1973 are tabulated below:

Pair	Height *ft*	Height *m*	Difference *ft*	Difference *m*
1	59.6	18.17	9.7±1.2	2.96±0.37
	69.3	21.13		
2	57.9	17.65	4.0±1.7	1.22±0.51
	61.9	18.87		
3	76.4	23.29	Not significant	
	79.1	24.12		
4	84.6	25.79	Not significant	
	86.1	26.25		
5	83.2	25.37	6.5±0.52	1.98±0.16
	89.7	27.35		

For each clonal pair whose heights were significantly different in 1973, the difference developed early in the life of the stand in the sapling stage (fig. 2). Subsequent growth rates in a pair have been rather similar. In clonal pair 3, a moderate difference in early growth was subsequently reversed, and heights have been similar since 1935.

The site index estimates for the site of clonal pair 1 would have differed considerably, depending on which clone was used for the estimate and at what age. Clonal differences in site index at the other sample locations ranged from moderate to trivial, and the estimates again change with age:

Pair	SI_{80} estimated at BH ages— 30	50	65
1	76	65	65
	97	80	76
2	74	64	63
	80	68	68
3	107	87	85
	107	89	86
4	120	96	93
	127	97	95
5	122	98	92
	129	102	98

Discussion

This small sample conforms with the impressions of general observation—that quaking aspen clones of the same age on the same site, though sometimes differing considerably in height, usually do not differ very much. However, in any program of collecting roots for production of planting stock, there is an opportunity to collect from clones of superior growing ability.

In collecting, however, one should not ignore other traits which differ from clone to clone and which, for various sites and considerations, may be important. Clonal differences in susceptibility to major decay fungus *Phellinus*

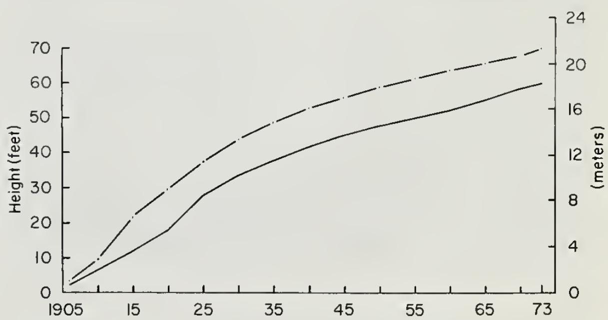

Figure 2.—Height-age curves for clonal pair 1. These two clones differed more in height growth than any other pair studied.

[3]*Jones and Trujillo, Manuscript in preparation.*

tremulae (formerly *Fomes igniarius* var. *populinus*) are sometimes suggested by differences in the abundance of conks. Wall (1971) showed that the difference is real. Further, by studying clones occurring together across different kinds of sites, he found that both the growth of different clones and their susceptibility to decay responded differently to site changes. Egeberg (1963) found major differences in clonal susceptibility to frost damage, which may be very important on some sites and not at all on others. Various writers have found differences in field and greenhouse suckering ability of different clones, and in optimum conditions for suckering (Barnes 1969, Farmer 1962, Tew 1970). Barnes (1969) described important differences between clones in stem form and self pruning, differences that the field forester may sometimes notice for himself.

Where natural regeneration is to be relied on, the forester must make the best of the clone on the site. In the West, a single clone often will occupy several acres (Tew et al. 1969). But if, for example, most stems in a given clone are forked, as occasionally happens (Barnes 1969, Jones 1967b, p. 127), regenerating the site by natural suckering may be undesirable. Steneker (1974) has suggested ways of favoring selected clones in regenerating an area naturally, but these are suited only to stands that are a fine mosaic of clones of small area, an exceptional situation in the West.

Every clone in this study seems, at age 30, to have seriously overrepresented site index. The site index table was developed largely from Colorado and New Mexico stem analysis data, and even for that area, site index estimates from 30-yr-old stands were often very inaccurate (Jones 1966, 1967a).

At an age (breast high) of 65, approaching the base age of 80, estimates are almost surely very close, and are approximated well by the estimates at age 50.

Conclusions

Aspen site index estimates from 30-yr-old stands are likely to be very inaccurate.

Although different aspen clones growing on the same site commonly do not differ much in height at maturity, some differ substantially. Any aspen planting program should take advantage of superior growth potentials as well as other inherent clonal differences. Height growth differences between clones at age 30 or younger may sometimes be reversed, however, at least if the difference is not large. Therefore, clonal material for planting should ordinarily be collected from older stands.

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Agriculture—CSU, Ft. Collins